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AN ECONOMIC ANALYSIS OF ARMY ENLISTMENT SUPPLY

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This research ~~note~~ addresses methodological problems involved with modelling enlistment behavior, and develops an econometric forecasting model. Previous time-series forecasting models have been subject to a variety of problems including incomplete specification of lag structures, and model misspecification. These problems are discussed and corrected in this model. Unemployment, military compensation, and recruiters all appear to influence enlistment rates, and are (over)

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incorporated into a model used to generate enlistment forecasts through 1990. The results indicate that the economic recovery and the declining youth population have already led to a fall in the number of high-quality male recruits, and the shortfall is expected to become worse over time. If military compensation and recruiting resources are held constant, and the economy continues to improve, the number of GSM 1-3A recruits may fall short of goals by 40 percent or more by 1990. However, the model also demonstrates that timely recruiting policies may countervail these negative influences.

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AN ECONOMIC ANALYSIS OF ARMY ENLISTMENT SUPPLY

EXECUTIVE SUMMARY

Requirement:

The continued success of the volunteer force depends upon the ability of the military to meet its manpower requirements. Over the last several years the recruiting effort has been successful in attracting a large number of high quality men and women. Enlistment goals have been surpassed by the Army since 1979. However, as the economy improves and the teen population falls, high quality recruits will be less likely to enlist, and the Army in particular will face recruiting difficulties. While policy tools are available to reduce the projected shortfall, manpower managers must have accurate projections of future enlistment trends and implement effective policies before such shortfalls become critical.

Procedure:

Enlistment projections have been estimated since the volunteer force was first considered as a viable option. This study analyzes the problems endemic to the enlistment forecasting literature. In particular, studies over the past few years have: (1) not controlled for structural changes in the enlistment model, (2) used little or no seasonal adjustment of enlistment data, (3) used accessions rather than contracts, (4) disregarded simultaneity problems involving the number of recruits and manpower goals, and (5) had problems with lagged variables. We consider these estimation problems and derive an econometric model which improves upon past time-series enlistment models. Forecasts of the number of high quality males are generated from this model, along with confidence intervals. An error analysis is also provided.

Findings:

The Army has set goals for the number of high quality males to be 64,900 per year from 1984 to 1990. Our projections show that, with no increase in the level of recruiting resources, the enlistment shortfall would be expected to rise from 19 percent for fiscal 1984 to 44 percent by 1990 (Table 5). This may be an overly optimistic view, since the declining youth population will likely drive up youth wages and decrease youth unemployment relative to the rest of the population. These forecasts are conditional on specific assumptions, i.e., that unemployment will fall gradually to 1990 (as predicted by the Congressional Budget Office), that military compensation will rise at the same rate as civilian compensation, that national advertising expenditures are held constant in real terms, that recruiting resources in general are also held at 1984 levels, and that the number of recruiters per eligible male remain constant. The projected shortfall will be smaller if the economic recovery is interrupted, if military pay raises rise faster than civilian wages, or if recruiting efforts are increased.

Utilization of Findings:

While prudent and timely manpower policies can reduce the shortfall, such policies are unlikely to eliminate the shortfall altogether. We suggest that the Army consider other manpower options as well. These include: (1) restructuring the compensation package to become more competitive in the youth labor market, (2) increasing the level of recruiting resources, (3) recruiting more from other groups, such as women, or lower AFQT category males in those military occupational specialties where there is little loss in productivity, (4) using more civilian workers, when appropriate, and (5) utilizing a smaller manpower force, either by becoming more capital intensive, by adopting strategic goals which require a smaller force, or a combination of these policies. We stress that the appropriate planning should be undertaken before the shortfall becomes critical.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. Introduction

The success of the volunteer force depends upon the ability of the military to meet its manpower requirements. Over the last several years the recruiting effort has been successful in attracting a large number of high quality men and women. Army recruiting exceeded overall enlistment goals from 1979 to 1983. However, some observers are concerned that this trend may soon be reversed. This concern stems from several sources. While the Army is seeking to maintain the active service strength, a number of factors may impede this expansion. First, the economy is currently recovering from the most severe recession since the great depression of the 1930's. The teenage (16-19) unemployment rate peaked at 25.5 percent in the last quarter of 1982, reaching 22 percent for white males and 48 percent for black males. As the economy improves, additional demand for labor will reduce unemployment and increase wages, inducing more youths to enter the civilian labor market.

Another factor expected to reduce the number of Army accessions is the decline in the number of eligible males. The population of 16–19 year old males is projected to fall by 9.6 percent between 1984 and 1990. In addition, Congress has mandated that, as of 1983, at least 65 percent of male accessions be high school graduates, with no more than 20 percent from the group scoring below the 30th percentile on the Armed Forces Qualification Test. Those scoring lower on the AFQT must be rejected from military service.

Finally, recent increases in the defense budget have not been financed through higher taxes. Congressional Budget Office projections show the deficit rising from $190 billion in 1984 to $326 billion in 1989. Should public and congressional pressure result in some combination of tax increases or spending cuts to reduce the size of the deficit, defense spending may be a target of these spending cuts. In that case, planners may be forced to reallocate resources between new weapons systems and manpower programs. If either military compensation or recruiting resources are reduced, high quality accessions will fall. The size of the budget deficit, in conjunction with a lack of consensus on how to deal with the deficit, casts doubt upon the future magnitude of defense manpower funding.

The greatest recruiting challenge facing the Army is to attract a sufficient number of "high-quality males", particularly males who are high school graduates scoring above the 50th percentile on the AFQT (category 1-3A). Evidence suggests that the number of category 1-3A high school graduate or senior male (GSM 1-3A) accessions is supply constrained. Total manpower goals are met by accepting lower category or non-graduate males as needed. This suggests that the first sign of recruiting difficulty may not be a fall in the total number of accessions, but rather a decrease in the percent of accessions from GSM 1-3As. Although a decrease in GSM 1-3As may or may not have a significant immediate effect on the ability to man the active force, the emphasis on maintaining the quality of the force requires that the Army be able to compete successfully for this group.

This paper models the supply of GSM 1-3As males (with no prior military service). A multivariate regression model is developed and estimated using generalized least squares to correct for serial correlation. The model is then used to predict future accession rates for this group. The theoretical framework for enlistment behavior is developed in Section II, and the institutional framework of the volunteer force is discussed. The data and methodology are presented in Section III. Estimates and forecasts are presented in Sections IV and V respectively, followed by concluding remarks in Section VI.

Although the supply of Army accessions has been estimated by a number of economists in recent years, our results suggest that many competing models are misspecified. In particular, the results of a number of models may be artifacts caused by incomplete seasonal adjustment of some very cyclical data, from improper selection of the time-series horizon, and from excluding (including) significant (insignificant) variables in the model. The results of the regressions presented in Section IV imply that unemployment, real military compensation, advertising expenditures and the number of recruiters per eligible male are all important and significant determinants of the supply of GSM 1-3As. While this is consistent with economic theory, many models find no significant impact of one or more of these variables. The policy implications of this debate relate not only to the ability to forecast accessions, but also to whether policy tools are available to influence the number of accessions. The economic determinants of accessions and effective policy tools must be identified, and the impact of such variables measured, in order to maintain a volunteer force.

II. Theoretical Framework

Economic theories of enlistment emphasize that military service is an alternative to either working in the civilian sector or attending school. The individual's choice will depend upon economic criteria as well as personal preferences, which are influenced by social attitudes and other factors. The economic model suggests that, other things constant, the costs and benefits of each alternative are compared against the other alternatives, and the career path yielding the highest rate of return will be chosen.

The enlistment model which underlies previous work, either explicitly (e.g. Fisher 1969, Goldberg 1982) or implicitly, is a one-period model. The model assumes two choices: one can work in the civilian sector for a wage W_c, or enlist in the military for a wage W_m. Given the utility or disutility of the military lifestyle relative to the civilian lifestyle (X), the individual compares the two alternatives. The individual will be indifferent when:

1. $W_c = W_m + X.$

The wage W_c which satisfies equation 1 is the individual's reservation wage, denoted W_r. The decision to enlist implies that $W_r \geq W_c$, and to work implies $W_c \geq W_r$.

Unfortunately, this model provides very little insight into the actual decision-making process of the individual. Given individuals who attend school, the opportunity cost (W_c) implicit in equation 1 is likely to have little influence on the enlistment decision. A student earning a degree in nuclear engineering, for example, might be unable to find a job paying more than minimum wage as a first year student. Certainly the minimum wage is not the appropriate civilian wage opportunity cost in this case. The enlistment model is extended in this section to incorporate the concept of investment in human capital over the life cycle.

The model of enlistment behavior compares the present value of different career choices. One particularly important nonpecuniary factor involved with the decision is the disutility of the military "lifestyle." The pecuniary value of this factor will be denoted by X, a premium for the hazards of military duty, the rigorous training and the loss of some personal freedom. These negative characteristics may be offset by the sense of adventure and opportunities for travel. Thus X is defined as the premium required to compensate for the military lifestyle. The enlistment decision can now be formalized: the individual is assumed to choose that alternative which maximizes that person's utility function, which includes the present value of the life cycle earnings plus the nonpecuniary costs and benefits included in the military lifestyle premium.

The present value of each alternative can be specified in fairly simple terms. Assuming the individual is considering employment, where "investment" in human capital is limited to on-the-job training (experience), the present value of the career choice can be written as:

2. $$PV_w = \int_{t=0}^{R} e^{-rt}\, WK_0\, e^{\rho t}\, dt,$$

where

r is the individual's discount rate,
R is the date of retirement,
W is the wage rate (the marginal product of capital),
K is the individual's stock of human capital,
ρ is the rate of capital accumulation of experience, (net of depreciation),
K_o is the initial endowment of human capital, at t=0.

At the beginning of the individual's working life, their initial productive capacity or capital stock is K_o, and earnings are $W_c K_o$. The person may increase earnings over time by investing in additional human capital. Schooling, training, and work experience all lead to such capital accumulation. Over time the job skills depreciate, so the rate of growth in K depends upon the relative amounts of investment and depreciation at any point in time.

Military Service Vs. Civilian Employment. The present value of earnings for a recruit who works in the civilian sector upon separation from the military is denoted as $PV_{m/w}$, where

$$3. \quad PV_{m/w} = \int_0^S e^{-rt} K_o W_m e^{\rho t} \, dt + \int_S^R e^{-rt} W (K_o e^{\rho(t-S)} + K_m e^{\rho(t-S)}) dt - X,$$

where

W_m is the military wage rate,
K_m is the human capital derived from military training, such that $K_m = \int_0^S K \, dt$,
S is the amount of time in the military, and
X is the relative disutility of military service.

Training in the military provides some skills which may be marketable in the civilian sector. The amount and valu^ of the training depends particularly on the assignment of the individual to an occupational specialty. To the extent that such skills can be transferred to the civilian job market, the value of the general training can be estimated by K_m, the increase in human capital generated by the training. K_m may be relatively small for an individual assigned to infantry, but may be much higher for someone trained in communications or electronics, mechanic maintenance, aviation maintenance, or automatic data processing, for example. The value of the training in the civilian sector of this training would equal $K_m W_c$, given the civilian wage rate.

The military wage rate, W_m, includes not only monthly pay but other types of indirect compensation. These include enlistment bonuses, education contributions and bonuses, PX and commissary benefits, health care, retirement benefits and other forms of compensation. It is implicitly assumed that the growth in military compensation $(W_m K_m e^{\rho t})$ equals the rate of growth in the civilian sector $(W_c K_o e^{\rho t})$, an assumption which simplifies the derivation of the reservation wage.

The reservation wage W_r is defined as that military wage rate which would leave an individual indifferent between civilian employment and military service. At the reservation wage, the discounted value of the civilian employment will equal the discounted value of the enlistment/civilian alternative net of X, the lifestyle premium. Therefore

4. $$W_c = W_r \Leftrightarrow PV_w = PV_{m/w},$$

which in turn means that

5. $$\int_0^S e^{(\rho-r)t} K_o(W_c - W_r)dt = \int_S^R e^{(\rho-r)t} [K_o(1-e^{-\rho s}) + K_m e^{-\rho s}]dt - X.$$

When $K_m = K_o^{(e^{\rho s}-1)}$, the term in the brackets becomes zero and equation 5 simplifies to

6. $$\int_0^s e^{(\rho-r)t} K_o(W_r - W_c)\, dt = X.$$

Equation 6 implies that the wage difference between the reservation wage and the civilian wage, discounted to the present, is simply the premium X. To simplify once more let $\rho=r$ and $K_o = 1$, such that

7. $$W_r = W_c + X.$$

Equation 7 is the specification that most economists have used since Fisher (1969). The reservation wage will vary across individuals because the value of X is a matter of personal preference and because W_c varies from person to person. As the military wage rate rises, $W_r > W_c$ for more persons, which in turn leads to higher enlistment rates.

Equation 7 only holds if $K_m = K_o(e^{-\rho s}-1)$, that is, if the military training equals the foregone training (particularly experience) in the civilian sector. By leaving the civilian work force, wage growth from the initial allocation of capital (K) is delayed. The enlistee loses civilian experience but gains military experience, which will have an impact on earnings throughout the life cycle. This specification emphasizes the importance between the value of training and the foregone experience in the civilian sector. This is consistent with survey data, which demonstrate the importance of job training on the enlistment decision (e.g. Gade et al., 1984). The more general specification of equation 5 demonstrates the importance of training in this life cycle model of earnings.

An issue of some debate is which civilian pay series should be used to estimate W_r. It is clear that W_r is a simple function of "youth wages," W_cK_o, only if $\rho=r$ (see equation 6). This assumes that $K_m = K_o(e^{\rho s}-1)$ and that the real discounted value of pay does not change over time. W_r cannot be defined as a simple function of $W_c K_o$ in the extended model of equation 5. Though some studies have advocated using the youth wages as an opportunity cost of enlisting (e.g. Goldberg, 1982, Ash et al., 1983), this theoretical specification casts doubt on the preference of using youth wages over other wage measures.

Military Service Vs. Additional Education. The analysis becomes more complicated if individuals plan to pursue education beyond high school. This analysis is limited to those who have chosen to attend post-secondary schooling, who must decide whether to enlist before pursuing further education. This option has become more attractive as a method to finance such education. The Army College Fund offers a package of contributory benefits (the Veterans Educational Assistance Program, or VEAP) and bonuses (Kickers).

The life-cycle earnings of an individual who pursues post-secondary education is given by PV_s, such that

$$8. \quad PV_s = \int_G^R e^{-rt} W_c(K_o + K_s)e^{\rho(t-G)}\,dt - \int_0^S e^{-rt}\gamma\,dt,$$

where

K_s is the capital investment from schooling, such that $\int_0^S K\,dt = K_s$, and
G is the number of periods of post-secondary education,
S is the number of periods of military service,
γ is the cost of schooling.

If the individual decides to enlist first, the life-cycle earnings can be described in similar terms by $PV_{m/s}$, given

$$9. \quad PV_{m/s} = \int_0^S e^{-rt} K_o W_m + \int_{S+G}^R e^{-rt} W_c(K_o + K_s)e^{\rho(t-(S+G))} - \int_S^{S+G} e^{-rt}\gamma\,dt - X,$$

The reservation wage W_r is defined, as before, as that military wage at which the individual is indifferent between the two alternatives. In this case

10. $$W_m = W_r \iff PV_s = PV_{m/s},$$

which in turn implies

11. $$\int_G^R e^{-rt} W_c(K_o + K_s)e^{\rho(t-G)}dt = \int_0^S e^{-rt} W_m K_o e^{\rho t}dt + \int_{S+G}^R e^{-rt} W_c(K_o + K_s)e^{\rho(t-(S+G))}dt - X.$$

It is assumed for simplicity that $\int_0^S e^{-rt}\gamma dt \approx \int_S^{S+G} e^{-rt}\gamma dt$, and that for an individual who plans to pursue further schooling $K_m \approx 0$. The value of military training is likely to be less important for those who pursue further education rather than using the training upon separation from the Army. The model can be easily extended by adding K_m to the formula, but the results become more intuitive at this stage when K_m is excluded.

Simple manipulation of equation 11 yields the following equation:

12. $$\int_0^S e^{-rt} K_o W_m e^{\rho t}dt = (1-e^{-\rho s}) \int_G^R e^{-rt} \tau e^{\rho(t-G)}dt + \int_G^{G+S} e^{-rt} \tau e^{\rho(t-(G+S))}dt + X,$$

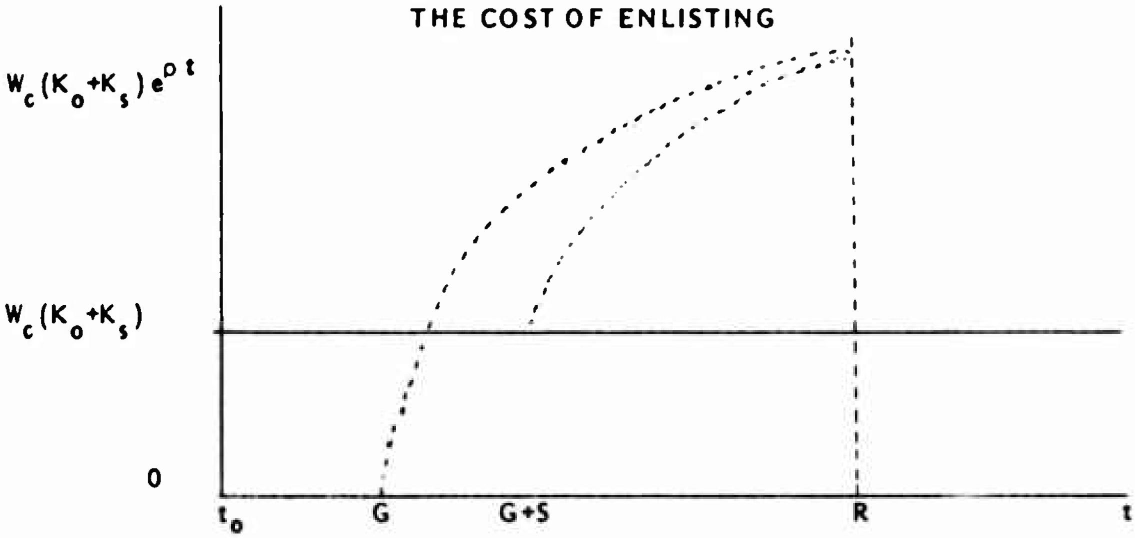
where

13. $$\tau = W_c(K_o + K_s).$$

This formulation has an intuitive explanation. When an individual planning to pursue further schooling does enlist in the Army, he or she receives some pecuniary compensation as discussed previously. There are two components to the financial cost of enlisting. The first term to the right of the equality in equation 12, which will be denoted as (a), is the foregone earnings over the life cycle caused by deferring the earnings growth. The second component, denoted by (b), is the earnings foregone over the years G to G+S. The tour of enlistment delays graduation from college, for example, and therefore delays civilian earnings by G years. This is illustrated in figure 1 below.

FIGURE 1

THE COST OF ENLISTING



If "graduates" of post-secondary educational institutions start at salaries which are unaffected by enlistment, then civilian earnings start at $W_c(K_o+K_s)$, and equation 12 can be rewritten simply as

$$14. \quad \int_0^S e^{-rt} K_o W_m e^{\rho t} dt = a + b + X.$$

On the other hand, if military experience is equal to civilian experience then $K_m > 0$, and equation 13 can be written

$$15. \quad \int_0^S e^{(\rho - r)t} K_o W_m dt = a + X,$$

that is, that the (discounted value of) military compensation equal the (discounted value of) the foregone earnings plus a premium for the military lifestyle. This is comparable to equation 7. If $\rho = r$, solving for the reservation wage (where $W_r = W_m$), equation 15 can be written as

$$16. \quad W_r = a + X.$$

Note that (a) is not simply W_c, since the foregone earnings in this case are those which are earned after completing school. In this case, youth wages are <u>not</u> the opportunity cost of enlisting given the decision to attend school, even in the simple case. Equation 12 defines the reservation wage under more realistic assumptions. It is also clear that W_r as defined in equation 12 will not generally equal the reservation wage defined by equation 5. The reservation for an individual attending school will not generally equal the reservation wage for an individual in the labor force.

Model Implications. The previous analysis derives the reservation wage for enlistment under two alternative scenarios in a life-cycle framework. This model is relatively simple because it deals with only one stage of a full life-cycle optimization model. The reservation wage itself cannot be observed for any individual. However as military compensation rises, it will exceed reservation wages for more individuals, causing enlistment rates to rise. The specification of the reservation wage is therefore important in determining the enlistment supply function.

The life-cycle model of the reservation wage demonstrates that the model expressed in equation 7 is derived only as a result of very strong assumptions, including a net discount rate of zero ($\rho = r$) and a zero value of military training ($K_m = 0$). Furthermore this condition is only derived for persons who do not plan to pursure further education or training. In the more general case the opportunity cost of enlisting is not the current foregone wage, but rather includes the discounted value of future wages as well (for example, equation 14). Since life-cycle earnings are generally not available, the model offers some insight into the appropriate earnings series to use as a measure of civilian wages W_c. Youth wages are strictly appropriate only in the simple model described by equation 7.

Another implication of the life-cycle model is the form of the military-civilian wage comparison. If there is some predetermined premium X which is attached to military service, then the potential recruit is assumed to enlist when $(W_r - W_c) > X$ (from equation 7) or $(W_r - a) > X$ (from equation 16), under the simplifying assumptions. The wage difference influences enlistment behavior in this model, not the wage ratio as used in most empirical studies. The use of the wage difference utilized in this study can be justified on theoretical grounds.

III. Data and Methodology

The discussion of the previous section implies that several economic and demographic variables could be expected to influence enlistment decisions. These variables are included in the supply model which is specified below.

The general form of the model can be specified simply as:

17. $S = F$ (Pay, Unemp, Recruit, MPOP, Adver),

where the variables are defined as:

S is the supply of Cat 1-3A GSM's,
Pay is the real military compensation, relative to civilian compensation,
Recruit is recruiting resources,
MPOP is the population of eligible males,
Unemp is the unemployment rate,
Adver is expenditures on Army advertising.

Enlistment Supply. The supply of enlistees may be measured by several series. Accessions are defined as the number of individuals actually entering the military service. However, entry into the service may be delayed up to a year after the individual signs a contract. Some of these delayed entry program participants do not follow through with their commitment, resulting in a difference between the number of contracts and accessions. The actual decision to enlist is made at the time the contract is signed, and the contract is legally binding. Therefore, contracts and not accessions are properly modelled in this framework. Since the late 1970's almost all enlistment supply models have used contracts as the dependent variable, though Fernandez (1979), Ash et al. (1983), and Olvey et al. (1984) use accessions.

Compensation. Theory suggests that potential enlistees compare civilian and military wages. If military pay falls (rises) relative to civilian wages, the number of contracts should decline (increase). The wage variable included in this model is civilian wages minus military compensation, deflated by the consumer price index. Therefore, the pay variable should be expected to have a negative sign. Most studies use a pay variable which is the ratio of military to civilian pay. The absolute pay difference gives a better fit, but the regression results using the two variables are similar.

The military wage series used in this study, (a weighted average of E1 and E2 pay), is designated basic military compensation (BMC). BMC includes basic pay, the calculated tax advantage of the federal income tax exemption, and the value of subsistence items and housing services provided by the Army or allowances in place of these goods and services. BMC is a useful measure of compensation because there is little variation within grade and service. However, the BMC has shortfalls which undoubtedly influence the elasticity estimates derived from the model. BMC is only part of total compensation received by military personnel. Personnel who live off base generally receive a variable housing allowance to compensate for the difference between the basic housing allowance and local housing prices. Excluding this allowance from compensation is inappropriate when comparing military pay with other groups in the economy at any single point in time. Since the amount of the housing allowance varies across geographic locations, and appears to be zero for those who live on base (although housing services do have a positive value), the allowance may be ignored by potential recruits when facing the enlistment decision. Therefore, BMC may be more appropriate to include in the regression model. Other items are also excluded from BMC, such as special and incentive pay, supplemental benefits and allowances, bonuses, payments to retired members, commissary and exchanges, medical care, veterans' educational assistance benefits, and social security contributions. In fact, BMC accounts for only about 60 percent of all military personnel costs for DOD (GAO staff report, 1984).

It is unclear how much incentive these "hidden" forms of compensation provide to potential recruits. For example, basic pay, which is most easily observed, amounts to $749 per month for an E-4 with two years of service (1983). The regular military compensation, which consists of the BMC plus an average variable housing allowance, is $1,235 for the same grade. Because other items such as medical care, social security contributions, commissary and exchange benefits are not as visible as basic pay, and the benefits of tax exemptions may be undervalued for youths just entering the job market, the real impact of such compensation upon enlistment is unknown. These may very well be discounted relative to the basic component of compensation. While such a compensation program was functional for the pre-volunteer service, the compensation structure may be detrimental to the Army's ability to compete in the youth labor market. (See, for example, Binkin 1975).

For lack of a reliable civilian wage series for the targeted group of GSM 1-3A males, the average weekly production wage provides a reasonable proxy. This series is converted to annual data for easy comparison with the annual BMC figures. Goldberg

(1982), Ash et al. (1983, note 9) and others have argued that age-specific wages should be a better measure of opportunity cost for youths who enlist. However, the current foregone wage is not the true opportunity cost of enlisting for those planning to pursue continued education. Moreover, as Brown (1983) notes, there are other problems with using youth wages.

Bonuses and educational benefits are not included in the BMC series but are part of the total compensation package. Educational benefits, known as the Veterans Educational Assistance Program (or VEAP), have replaced the GI Bill. VEAP is a contributory program. For each dollar the enlistee contributes to a college fund, the government contributes two dollars (up to a ceiling). Moreover, if the enlistee is a GSM 1-3A participating in the VEAP program, he may qualify for an additional bonus (the Kicker), by entering a designated military occupational specialty. This bonus is worth up to $12,000 currently. In addition, all enlistees are eligible for cash enlistment bonuses up front if they join designated military occupational specialities (MOS) at the time of enlistment.

While the VEAP program and the cash bonuses undoubtedly contribute to enlistment motivation, there are a number of difficulties involved with estimating the impact of each program. Many eligible GSM 1-3As do not participate in the VEAP, and those who do participate often contribute much less than the maximum. The cost of the program can be easily identified, but the value to the serviceman is ambiguous since present consumption must be sacrificed to participate in the program. Moreover, because the VEAP ceiling has not increased since the program began in 1977, the impact of VEAP on enlistment cannot be accurately estimated in a time-series regression model.

Brown (1983) attempts to avoid these problems with VEAP benefits by combining the average discounted value of the benefits with the pay variable to yield a total compensation term. There are several problems with this approach. First, only 25 percent of the total enlisted (DOD) population participated in VEAP over the first four years of the program, and of those, approximately one third had disenrolled by 1981. For any person not participating in VEAP, the value of the benefits is clearly zero. Secondly, the VEAP program is contributory, so any VEAP participant must defer present consumption to qualify for future tuition benefits. Most enlisted persons are just beginning their work career, so their net worth and earnings are relatively low. Saving out of current income to contribute to VEAP may be difficult for these youths, and implies a high opportunity cost. It is inappropriate to value VEAP benefits as equal to regular compensation. This may be partially responsible for the "anomolous result" of the education coefficient in Brown's enlistment regressions (p. 19).

Two types of bonuses are offered in the U.S. Army. The Army College Fund "Kicker" is available to participants in the VEAP program who enlist in specific MOS, and the bonus is deposited into the fund. In addition, enlistment in a number of designated MOS entitles GSM 1-3As to cash enlistment bonuses. Both types of bonuses are designed primarily as allocation incentives. It is not clear how many of those receiving such bonuses (1) would have enlisted in the specific MOS without the bonus, (2) would have enlisted in other MOS if no bonus were available, or (3) would not have enlisted at all without the bonus. Unfortunately, quarterly data on total Army bonuses are not available. Bonus ceilings have increased several times since 1977, but such a measure is a poor indicator of actual bonuses paid by the Army. Furthermore, one might expect bonuses to increase in response to declines in enlistment, as the Army perceives growing shortages in particular MOS. This would lead to simultaneity problems in the model, which could result in a negative measured effect of bonuses on enlistment. Thus the impact of the VEAP, Kicker, and enlistment bonus upon enlistment is probably significant, but methodological and quantitative problems prevent including these variables in the model. Some evidence on the impact of educational assistance on enlistment is discussed in Fernandez (1982).

Advertising. Advertising at the national levels appears to be quite significant, while local advertising expenditures have a small and statistically insignificant impact on enlistment. Brown (1983) includes advertising expenditures in an enlistment model. (Studies on various types of advertising show that most advertising components appear to be statistically insignificant, e.g. Morey 1980). The results of the Brown study are mixed. For GSM 1-3A males (over population), the national advertising elasticity in both GLS specifications ranges from -.05 to -.08. The elasticities from the OLS equations for the same group range from -.08 to .26. The elasticities vary similarly in the regressions on the other enlistment groups from -.07 to .27. Local advertising generally has the wrong sign in Brown regressions, but is insignificant in most cases.

Unemployment. While the civilian wage can be considered an opportunity cost for those who enlist, a weak economy will increase search costs and lock some youths out of the work force entirely. **A priori**, one would expect that changes in the unemployment rate affect the supply of contracts after some lag. As unemployment rises, the job search becomes more difficult, but the process of seeking work itself takes time. The impact of changes in unemployment should gradually rise over time, and then fall. There is no reason to expect that the full impact of changes in unemployment should be experienced within any single period. Estimation of such an unemployment effect, particularly with monthly data, may require using a distributed lag. Unfortunately, few of the contract supply studies to date have experimented with any type of distributed lag.

Past enlistment studies have sometimes used unemployment lagged one or more periods, or have excluded lagged unemployment altogether. Fernandez (1979), for example, used a number of (monthly) lagged unemployment variables, arguing that use of an Almon distributed lag will save few degrees of freedom if the lag structure is relatively short. However, over six to twelve months a distributed lag will save a considerable number of degrees of freedom. Furthermore, since unemployment will be highly collinear with lagged unemployment, the Fernandez approach introduces a great deal of multicollinearity into the regressions.

An earlier version of this paper utilized a quadratic Almon lag. The additional advertising variable reduced the need for a distributed lag. Unemployment now enters the equation with a first and second quarter lag. Current unemployment is not significant. The net effect of unemployment falls only slightly in this version.

The question of which specific unemployment rate should be used in the estimation is generally overlooked. Many studies use the male 16–19 year old unemployment rate. Since the average age of an enlistee is approximately 18–19 years, the 16–19 year old rate is not the most representative rate for the eligible male population. The 16–21 male unemployment rate is also published by the Bureau of Labor Statistics, and is preferred as being more representative. Moreover, a comparison of preliminary regression estimates demonstrates that the mean squared error of the model using 16–21 male unemployment and population series is approximately half of that generated by the same model using the 16–19 male statistics.

Recruiters. The data on recruiting resources for specific branches of the military is generally incomplete. Data are available on the number of Army recruiters and are included in the regression. If various recruiting efforts are correlated, which is likely, the recruiter variable may be acting as a proxy for the overall Army recruiting effort. The recruiter coefficient is expected to be positive.

Both recruiters and contracts enter the model as rates. The recruit variable is the ratio of the number of recruiters to the number of eligible 16–21 year old males. Enlistment is the ratio of contracts to the same population. This specification is consistent with a population elasticity of unity. Total contracts are then derived by multiplying the enlistment rate by the male population. Changes in the population have a direct impact on total contracts. As Goldberg (1982) notes, the population elasticity cannot be unity if recruiter levels enter the model. In that specification a change in population, holding the number of recruiters constant, will also change the number of recruiters per eligible male. In some models both enlistment and recruiter levels are used (e.g. Fernandez 1979), while in others the enlistment rate is regressed against the recruiter levels (Dale and Gilroy 1984 and Olvey et al. 1984).

Mission. It is likely that recruiting goals do affect the level of contracts. Recruiters have great incentives to reach the mission, and little incentive to exceed the mission. There are several objections to including goals in the regression. A rise in mission is likely to be accompanied by additional recruiting resources. Precise parameter estimates of the mission effect will therefore be impossible. However, if the correlation between mission and recruiting resources continues in the future, forecasting is still possible. A more serious objection to including mission is that contracts and mission are correlated. When accessions fall short of goals as in the past, the mission might fall to reflect the poor recruiting environment. In 1984, the shortfall of the first several quarters resulted in an increase in mission for the last quarters to meet the annual mission. This was accompanied by new recruiting and additional resources. The correlation between the dependent variable (contracts) and the independent variable (mission) leads to biased and inconsistent parameter estimates.

To test the sensitivity of the forecasts to the mission variable, the model was estimated adding mission as an independent variable. The variable was just significant at the .10 level, and had only a small positive effect on the forecasts of contracts.

The model estimated in this paper, expressed now in terms of rates, is

$$18.\quad \text{Contracts/MPOP} = \beta_i \sum_{i=1}^{2} \text{Unem}_{t-i} + \beta_3 \text{ Pay} + \beta_4 \text{ Recruit/MPOP} + \beta_5 \text{ Adver} + \varepsilon_t.$$

The population, unemployment and civilian pay data are published by the U.S. Department of Labor. The Defense Manpower Data Center provided some early contract data. The enlistment contract data, advertising expenditures and the number of recruiters came from the U.S. Army Recruiting Command.

The regression estimates from this model will be compared to estimates from a number of other accession supply models. A number of issues implicit in model estimation are often overlooked in analyzing regression results. These include: the choice of the appropriate time horizon, the choice of the period length, and adjustment for seasonal variation. These issues must be resolved if a model is to explain the enlistment behavior of the past and provide forecasts of future enlistment levels.

Serial Correlation. Several comments on the estimation procedure are appropriate at this point. The model exhibits a significant amount of serial correlation. This is corrected by using a generalized least squares regression techniques. A potentially serious problem is the simultaneity between the dependent variable, specifically the male population statistic in the denominator, and independent variables such as civilian wages and unemployment. The time horizon covered in the estimation (seven years) is relatively short, and the male population during the period is small. This simultaneity is likely to be more of a problem in the future if the declining male 16-21 population begins to exert downward pressure on unemployment and upward pressure on age-specific wages (predicted in Tan and Ward, 1983). For short-run prediction and modelling one would expect the effect of changes in the cohort size to have a small effect on age-specific unemployment and wages.

IV. RESULTS

Regression Results. The enlistment model expressed in equation 18 has been estimated using quarterly data covering 1977 Q2 to 1984 Q2. The two-stage GLS estimates are provided in Table 1 for several specifications. The results demonstrate that pay, unemployment lagged one and two quarters, the pay variable, the number of recruiters and national advertising expenditures are all significant determinants of enlistment. Current unemployment and local advertising are not statistically significant. This is demonstrated in regressions one through three. Regression four substitutes a pay ratio for the pay difference used in the other equations. The ratio term is significant, although the higher mean squared error demonstrates an inferior fit. The result is particularly interesting since most alternative studies utilize a ratio as the pay variable. Regression five and six exhibit two of the Almon polynomial lags fit to unemployment. Neither quadratic distributed lag fits the data very well. The final regression includes only those variables which appear to be significant. Unemployment lagged two quarters is significant at the .07 level. All other variables meet the .05 significance test. The coefficients are quite stable across various specifications.

Elasticities have been calculated for each of the significant variables from equation 7. Unemployment, with an elasticity of .73 (for both lags combined), has a large impact on the level of contracts. It is estimated that the fall in the male (16–21) unemployment rate from 17 percent to 16 percent, for example, resulted in a decline of almost 600 GSM 1–3A contracts per quarter. The impact of changes in the unemployment rate is felt after a lag of one to two quarters.

Military compensation is also quite significant. The pay elasticity based on equation 7 is 2.7. That estimate is preferred because the pay difference fits the model better than the pay ratio. The elasticity of 2.7 implies that a military pay increase of approximately 115 will result in a 390 increase in GSM 1-3A contracts per quarter. It is interesting to note that the pay ratio generates an elasticity of 2.1, because most enlistment studies use the ratio in place of the pay difference.

The recruiter elasticity is .76. This implies that 100 additional recruiters will

TABLE 1

REGRESSION RESULTS
1977 Q2 - 1984 Q2

Regression	Intercept	U	U_{-1}	U_{-2}	Pay	Recruit	N Adver	L $Adver_{-1}$	ρ	R^2	MSE
1	-48.4 (0.7)	-	3.11 (2.9)	2.18 (2.0)	-0.023 (3.0)	2.92 (2.8)	0.51 (2.8)	-	.70	.90	24.4
2	-	0.23 (0.23)	2.57 (2.70)	2.24 (2.23)	-0.028 (7.1)	2.09 (2.9)	0.52 (3.3)	0.24 (0.9)	.76	-	20.7
3	-	-	2.66 (3.2)	2.26 (2.3)	-0.028 (7.4)	2.15 (3.5)	0.52 (3.4)	0.23 (0.9)	.79	-	19.5
4	-4.18 (5.3)	-	3.65 (3.2)	2.01 (1.7)	316.11[c] (2.5)	3.98 (4.0)	0.58 (2.9)	-	.61	.92	29.0
5[a]	-	0.23 (0.2)	2.62 (2.3)	1.99 (1.8)	-0.028 (7.6)	2.30 (2.9)	0.47 (2.5)	-	.67	-	26.9
6[a]	-	0.30 (0.3)	2.50 (3.6)	2.28/.35[b] (3.3/0.3)	-0.028 (7.5)	2.36 (2.8)	0.48 (2.6)	-	.67	-	26.8
7	-	-	2.73 (2.8)	2.03[d] (1.9)	-0.028 (7.9)	2.33 (3.5)	0.47 (2.7)	-	.71	-	24.8

U = unemployment.

N Adver = National Advertising.

L Adver = Local Advertising.

ρ = autoregressive parameter.

MSE = Mean Squared Error.

[a] Distributed Lag equation - quadratic Almon Lags.

[b] Coefficients, t's for second and third lag.

[c] Pay ratio.

[d] Significant at .07 level.

t statistics in parentheses.

induce 232 potential recruits to enlist per quarter, or just over 9 per year per additional recruiter. This includes only GSM 1-3A enlistment. Additional recruiters will yield more contracts from other categories as well.

Finally, national advertising appears to be statistically significant, although local advertising expenditures are not significant. The elasticity, however, is quite small. The elasticity of .044, based on an expenditure level of $45.6 million over the last four quarters, implies that a $100,000 increase in the level of expenditures per quarter should result in 5.6 additional GSM 1-3A recruits per quarter. At this rate, the cost of a single additional contract is $17,857. This number appears unduly high, particularly compared to estimates from other studies (e.g. Morey 1980).

TABLE 2

END POINT ELASTICITIES

Unemployment	.73
Military Pay	2.7
Recruiters	.76
National Advertising	.044

Comparisons With Other Studies. Enlistment elasticities have been produced by numerous studies over recent years. These elasticities exhibit a wide range of values, as demonstrated in Table 3. This section begins with a simple comparison of the various elasticities in the literature with those found in this study. This is followed by a discussion of factors which may explain some of the differences between the studies. While many of the elasticities are end point elasticities, some (e.g. Brown 1983) are average elasticities, while others are ambiguous. In addition, the variable values have changed substantially over the past few years. Therefore the elasticities are not directly comparable in many cases.

It is clear from Table 3 that the current study is the only Army analysis other than Brown (1983) which finds unemployment, pay, recruiters, and advertising to be significant. Brown includes advertising in the model, while only Goldberg (1983) and Brown find recruiters to be significant with the correct sign. Daula et al. (1982) and Baldwin et al. (1982) obtain a significant recruiter effect with the wrong sign. (Perleman (1983) shows elasticities for a number of other studies).

The unemployment effect receives much attention in the popular press. Yet many studies find no significance to unemployment (e.g. Fechter 1978, Fernandez 1979, Ash et al. 1983 and Goldberg 1982). Withers (1978) finds a significant negative relationship between Army enlistment and unemployment. At the other extreme Daula et al. (1982) arrive at an unemployment elasticity of 2.3, though a revised version of the paper finds a much lower measure of .93 (Baldwin et al.). Only Dale and Gilroy (1983, 1984) find comparable elasticities using time series data. Our elasticity is higher than most other numbers in the literature.

Most studies find pay to be significant, though again the elasticities differ widely. Our pay elasticity is high relative to most studies, though less than the elasticities found by Daula et al. (1982) and Baldwin et al. (1982). The pay elasticity based on the pay ratio is closer to most published estimates, which is not surprising since ratios are generally used in the studies.

The recruiter elasticity of .76 is higher than that found by Brown (1983) or Goldberg (1982). Other studies, as previously noted, produce insignificant or negative recruiter effects. Our elasticity is much higher than expected, and would indicate that much of the effect of the declining youth population may be offset by the higher

TABLE 3

ARMY ELASTICITIES: OTHER STUDIES

Study	Period	Elasticity: Unemployment	Elasticity: Pay	Elasticity: Recruiter	Elasticity: Advertising
Time Series:					
Fechter (1978)[a]	Qtr: 1/58–11/74	*	1.15	N/A	N/A
Grissmer (1978)	Mon: 6/70–7/75	.37–.42	1.2–1.9	N/A	N/A
Withers (1978)	Qtr: 2/66–4/73	–.29	.28	N/A	N/A
Fernandez (1979)	Mon: 7/70–9/78	*	*	*	N/A
Dale and Gilroy (1983)[b]	Mon: 10/75–3/82	.94	2.3	*	N/A
Dale and Gilroy (1984)	Mon: 10/73–3/82	.8–1.0	.9–1.7	*	N/A
Ash et al. (1983)[b]	Semian: 1/68–2/76	*	.88	N/A	N/A
Horne	Qtr: 2/77–2/84	.73	2.7	.76	.044
Cross Section:					
Daula et al.[c] (1982)	1978	2.3	3.36	b	N/A
Baldwin et al.[c] (1982)	1978	.93	3.54	b	N/A
Pooled Cross Section:					
Goldberg (1982)	An: 1976–80	*	2.13	.30	N/A
Brown (1983)[d]	Qtr: 4/75–3/82	0.5	.79–1.16	.42–.64	.05–.08

[a]uses employment rather than unemployment rate.
[b]significant and negative – elasticity not provided.
[c]estimates of all high school graduate males.
[d]elasticities are from GLS estimates 1976(4)–1982(3), GSM 1–3A male youth population.
*coefficients are not significant.

recruiter concentration, holding the absolute number of recruiters constant.

The recruiter elasticity indicates that one additional recruiter should increase the number of GSM 1-3As by 2.3 per quarter. Jehn and Shughart (1979) estimate the marginal effect of Navy recruiters in 1973 to be 2.2 for high school graduates, which is consistent with our results. The comparison is informative, although the marginal product of a Navy recruiter in 1973 could be quite different from the marginal product of an Army recruiter in 1984 for many reasons.

A dependent variable problem stems from the fact that recruiting goals over the past several years have been met or exceeded. Some individuals eligible for enlistment are rejected by the Army when quotas are exceeded. Therefore the actual number of contracts is at times determined by the Army demand. Given the difficulty of modelling the demand for recruits, the resulting identification problem severely handicaps attempts at supply estimation. There have been two responses to the problem. The first is to simply ignore the problem, and estimate total contracts using all males (Dale and Gilroy, 1983; Ash et al., 1983), or all high school graduates (Daula et al., 1982; Baldwin et al., 1982). The more common alternative is to estimate GSM 1-3A contracts only, since these recruits receive first priority in enlistment.

Most enlistment supply studies assume that the underlying structural model remains constant for the period of estimation. However, there is clear evidence to suggest that the motivations to enlist in the volunteer force are quite different from the motivations which encouraged enlistment in the draft era and during the Vietnam war in particular. Many studies span both eras and do not test for stability of the coefficients (Ash et al. 1982, Grissmer 1978, Fechter 1978, Fernandez 1979, Cooper 1977 and Olvey 1984). Withers (1978) uses only draft era data. While no stability test is needed in the Withers model, the elasticities from the draft era cannot be assumed applicable to the post draft enlistment behavior. Dale and Gilroy (1983) and Brown (1983) use historical data only from the all volunteer force period. Ash et al. (1983) and Fernandez (1979) include a time trend, which cannot adequately control for structural shifts in the model.

Recruiting policy changed in FY 1980. For the first time the recruiters were given missions for specific AFQT categories. The stability of the model tested using the Chow test; utilizing the regressions run over 1977 second quarter to 1980 third quarter, and from 1980 fourth quarter to 1984 second quarter. The F statistic value of 1.99 is within the five percent $F_{7,22}$ value of 2.46. The hypothesis of stable coefficients is accepted.

The Dale and Gilroy (1983, 1984) analysis which begins in 1975, encounters another problem. The GI bill was maintained for several years after the end of the draft. Termination of the program in 1976 caused several large swings in enlistment through 1976. The swings can be "explained" by use of dummy variables for the period, which effectively excludes the period from determining unemployment and pay elasticities. Dale and Gilroy find the impact of the GI Bill termination to be quite significant. Surprisingly, almost none of the other time-series analyses covering that period include any adjustment for the GI Bill.

There is a compelling argument for excluding the pre-1977 data entirely: the large swings from the end of 1975 to the first period of 1977 interfere with the seasonal adjustment factor. In fact, the X-11 seasonal adjustment method used in this study is stable only when the pre-1977 period is excluded. This might explain the weak (insignificant) seasonal adjustment factor in the Dale and Gilroy analysis. In that study, the single seasonal dummy included for the third quarter is generally insignificant. However, the X-11 procedure on post-1976 contracts yields (calendar) quarterly seasonal adjustment factors of 110.9, 95.1, 99.7 and 94.4. The third quarter is the only quarter that does not need an adjustment factor.

An issue related to the choice of the time horizon is the optimal frequency of observations. Other things remaining the same, the more frequent the observations, the greater the number of observations that are available for estimation purposes and the larger are the degrees of freedom in the model. However, if the length of the period is too short, excess noise is introduced into the data. This is likely for contract data. Recruiting goals are fixed for "recruiting months," which may be either four or five weeks long and are not normally consistent with calendar months. If recruiting goals have been met before the end of the recruiting month, potential accessions may be deferred until the next accounting period. Th monthly contract data may be a function of where these recruiting months fall. Quarterly observations provide sufficient degrees of freedom for estimation, given the time horizon, while reducing the noise inherent in calendar month observations. The use of semi-annual observations (e.g. Ash et al. 1983) excludes much of the intra-year variation, and the loss of detail in the data through long term averaging cannot be replaced by using historical data. Such an approach is difficult to justify.

Insufficient seasonal or cyclical adjustment for some variables may lead to unexpected results. Military compensation, for example, rises once a year. The aggregate measure of civilian wages, on the other hand, rises gradually during the year. Therefore the pay variable, defined as either BMC/civilian wages or BMC minus civilian wages, increases dramatically one month a year, and then falls during the remaining eleven months. Depending upon the period covered, one can find pay to be significant or insignificant, positive or negative, by choosing various lags or leads. Dale and Gilroy (1983), for example, utilize one and three month leads to get reasonable pay elasticities, while Ash et al. (1983), using semiannual data, incorporate a one period lag to get reasonable coefficients. The civilian wage variable is, of course, a moving average of many wages changing over time. It is unreasonable to suppose that potential recruits only consider one month out of each year, comparing nominal BMC with the moving average of civilian wages. In this analysis the BMC variable is a simple moving average of BMC over the past year, which is compatible with the civilian wage data.

None of the time-series studies use any type of distributed lag in the equations. The attempt to estimate the impact of unemployment on contracts without using a distributed lag, particularly for monthly data, has often led to findings of an insignificant effect (e.g. Fernandez 1979). Dale and Gilroy (1983) find that unemployment in the current month, lagged two periods and lagged four periods are (jointly) significant, though the four-month lag was not itself significant in the regression. This lag pattern, however, cannot be theoretically justified, since there is no effect for the one- and-three month lag. An unemployment effect which is asserted in alternate months appears implausible.

The studies using pure time-series data have not generated any clear consensus. One alternative is to use cross-section data, although these are subject to a number of problems which are discussed in Brown (1983). Brown notes that "unmeasured taste and ability factors will be correlated with civilian compensation" (p. 9), which is particularly troublesome when earnings and attitudes vary within regions.

Several other problems are particularly relevant to the work of Daula **et al.** (1982), and a variation on that work by Baldwin **et al.** (1982). The first problem concerns the wage variable. In cross-section data, military pay does not vary. Therefore the only variation in the pay variable is derived from the civilian wage, which is not observable for recruits. Daula **et al.** estimate the unobserved civilian wage in a separate earnings equation, but the equation is misspecified. Earnings are regressed against eight variables, seven of which are not significant, including unemployment which has an unexpected positive effect on earnings (Table 4). The R^2 reported for the preliminary OLS earnings equation is .089. The result is an earnings variable which is unreliable, derived from a model which explains very little of the variation in earnings.

The weak unemployment effect found in the cross-sectional studies may be due to measurement problems. The studies use state unemployment, which can be a poor indicator of local labor market conditions. The variation within a state may be significant, not only in terms of rural-urban differences, but even among major standard metropolitan statistical areas (SMSA's). To the extent that one area experiences higher unemployment, individuals may work across state lines. The use of state unemployment rates, rather than SMSA or regional rates, may produce ambiguous results.

Baldwin et al. (1982) introduce a second unemployment variable, the rate of change in unemployment over the year. The unemployment rate itself is still significant, but its elasticity falls to .93. The interpretation of the two variables in this model is ambiguous, and the implications for manpower policy are not explained in the paper.

These cross-section studies use a very small sample. The 520 civilian observations represent some 12 million eligible males in the population. The civilian sample is limited to only those males not attending school. If those with more ability attend school, the wage equation has an additional source of sample selection bias. Moreover, in the enlistment choice equation, males in the civilian labor force are compared with all recruits, including those who are participating in the VEAP program to accumulate funds for schooling. This stratification can bias the estimates in the choice equation.

Finally, the military-civilian choice equation in Daula et al. and Baldwin et al. is likely to be misspecified. Of the seven independent variables, the minority, marital, and South variables are insignificant. Recruiter density is very significant, but has the wrong sign. These issues suggest that, despite the significance of the pay and unemployment coefficients, the elasticities may be unreliable. In addition, the final probit estimates do not converge.

A more promising approach uses pooled cross-section data. Goldberg (1982) uses annual observations over 1976-1980 to model the supply of GSM 1-3A contracts. The independent variables include SMSA unemployment rates and age-specific earnings. The period is characterized by relatively stable unemployment rates. Goldberg finds no significant unemployment effect, but military pay has a large impact on contracts, with an elasticity of 2.13 for the Army equation. The Army recruiter variable is also significant with an elasticity of 0.3.

Brown (1983) provides numerous estimates for several enlistment categories, using quarterly data covering 1975(4) to 1982(3). The most reliable estimates use the generalized least squares method on GSM 1-3A contracts over population. Unemployment and pay elasticities vary substantially across model specifications. A time trend, which is probably collinear with other variables, "explains" much of the variation in contracts. The second series of estimates adds recruiters and also national advertising, both of which are significant. Unemployment squared and local media advertising are both generally insignificant.

The Brown results should be interpreted with some caution. Some sixteen regressions are estimated for various contract categories, using both OLS and GLS estimation. BMC and education benefits are entered as dummies and as numerical values. While these comparisons are useful for addressing questions of stability and significance, no single equation is designated a best choice to derive elasticity estimates. Even within the GSM 1-3A GLS estimates, the first series of estimates excludes significant variables, while the second series includes insignificant variables. All equations contain a time trend, though such a variable is undoubtedly quite collinear with other variables and provides a poor measure of structural change over time.

Despite these caveats, the elasticities from the Brown study are fairly consistent with our results. The major disagreement concerns the pay effect. For GSM 1-3As, Brown's pay elasticity varies widely across models. Moreover, the derived elasticities for the educational benefits are much larger than the BMC and civilian wage elasticities, a result which Brown notes is anomolous since the elasticities should be equal. These pay elasticities may be a function of how the pay variable is derived, as discounted potential education benefits are simply added to BMC to provide a military compensation measure.

V. Enlistment Projections

Enlistment projections must be available to planners if effective manpower policies are to be implemented. Although a number of enlistment supply models are used to forecast future levels of enlistment, the choice of which is more "correct" is very difficult. This section begins with a brief discussion of forecast evaluation. Actual projections are then presented and compared with existing forecasts. Finally, the concluding statements discuss the outlook for attracting high quality males to the volunteer force.

Evaluating Forecasts. A forecast may be inaccurate for any of several reasons. Specification error, for example, may result because: (1) an incorrect functional form is used to represent the underlying model, (2) the structure of the model changes over time, (3) significant variables are omitted from the equation, or (4) insignificant variables are included in the equation. These problems have been discussed in the previous section. Most of the enlistment models in the literature are subject to at least one form of specification error. Forecasts derived from misspecified models are generally unreliable.

Predicted regressors are another potential source of forecast error. Enlistment forecasts generally require specific assumptions about future unemployment, civilian wages, military compensation, the number of recruiters, and the size of the population of eligible males. Errors in the regressors will introduce errors in the enlistment projections.

Models which may be reasonably accurate in the short run may be inappropriate to use in the long run. Most models of enlistment, including the present one, do not consider long run demographic or economic changes that become much more important over time. These enlistment models are really appropriate only for relatively short run forecasting. Even in the short run, the confidence intervals expand as the enlistments are projected further in the future. However the confidence intervals have not always been provided with the forecasts in the literature.

In the long run, of course, demographic and economic variables become important determinants of enlistment. The population of eligible males is decreasing, female participation rates are stabilizing, the economy is recovering from a prolonged recession, and these changes will affect the youth labor market. Jobs for this group should be easier to find, and wages should be increasing over time (e.g. Tan and Ward 1984).

The Fernandez (1979) forecasts are illustrative of many of the problems endemic to the enlistment literature. The variables in the model, except for an **ad hoc** dummy variable, are generally insignificant. The model is not tested for stability, although both draft and volunteer force years are included. The model, estimated over only eight years, is used to generate forecasts twelve years into the future. Youth unemployment, allowed to vary between 12.5 percent and 17.5 percent for 1983 in the study, reached 25 percent. Therefore it is not surprising that the forecasts are poor. The GSM 1-3A projections for 1983 ranged from 37,700 to 42,600, while the actual number of contracts in 1983 was close to 67,000, far outside the confidence intervals provided. This is the error after only five years of a twelve year forecast. The example demonstrates some of the forecasting pitfalls.

The Dale and Gilroy (1984) forecasts, on the other hand, currently are on the low side. Their one year ahead 1984 (OMB assumption) forecast of GSM 1-3As is 45,200, or about two thirds of actual contracts for the year. The projections fall to 40,600 for 1985, and to 31,800 by 1987. These projections appear to be low over the entire series.

Model Projections. The forecasts of GSM 1-3As derived from our model are presented in Table 4. Two forecast series are generated assuming a constant pay

TABLE 4

PROJECTIONS OF GSM 1-3A CONTRACTS

Fiscal Year	Upper Limit*	Forecast	Lower Limit*
1984	—	53,072	—
1985	50,882	45,804	40,723
1986	49,563	44,519	39,475
1987	48,468	43,429	38,390
1988	47,488	42,441	37,396
1989	46,571	41,508	36,445
1990	45,818	40,744	35,673

* 95% confidence intervals, assuming values of the independent variables are known with certainty.
The civilian unemployment rate is assumed to fall to 6.3 percent by 1989, corresponding to 14.5 percent rate 16-21 aged males, consistent with CBO projections.

TABLE 5

PREDICTED ACCESSIONS

Fiscal Year	Predicted Accessions*	Required Accessions	Shortfall Number	Shortfall Percent
1984	47,234	58,370	11,136	19.1
1985	40,766	64,900	24,134	37.2
1986	39,622	64,900	25,278	38.9
1987	38,652	64,900	26,248	40.0
1988	37,772	64,900	27,128	41.8
1989	36,942	64,900	27,958	43.1
1990	36,262	64,900	28,638	44.1

*Based upon 6 percent loss in delayed entry program, and a 5 percent reduction in the number of GSM 1-3As due to the renorming of the AFQT.

differential and no changes in the number of recruiters per eligible male. Since recruiting resources and goals did rise over FY 1984, these projections imply the level of contracts which would have been expected with no recruiting policy change. The effect of the various recruiting initiatives cannot be calculated at this time. The series allows the civilian unemployment rate to fall to 6.3 percent by 1989, which is consistent with the August 1984 unemployment projections of the Congressional Budget Office (CBO). The male (16-21) unemployment rate is derived from the civilian rate from a GLS regression using quarterly data for the last decade as shown in equation 19. The male (16-21) rate is therefore assumed to reach 14.5 percent by 1988. It should be noted that this youth rate enters the actual model, and the elasticity is defined relative to this rate as well.

$$19. \quad \text{Unemp (16-21)} = \underset{(2.03)}{1.76} + \underset{(19.31)}{2.03} \text{ Unemp (Civ.)}; \quad \rho = .52 \quad R^2 = .91 \quad \text{RMSE} = .46$$

The model under either assumption demonstrates the manpower problem facing the Army. These contract numbers do not adjust for the delayed entry program loss, which is more than 6 percent on average for GSM 1-3As. The renorming of the AFQT will also reduce the number of GSM 1-3A's available to the Army. This loss is (conservatively) assumed to be five percent. Given the target of 64,900 accessions for the next few years, the Army alone would be facing an accession shortage of approximately 44 percent by 1990 if no counteractive discretionary policies are implemented. This scenario is illustrated in Table 5. Hosek et al. (1984) suggest that the increase in retention rates experienced by the Army may reduce the number of accessions needed to maintain the desired manpower levels in the future. However, Army reenlistment rates for the latest month (August 1984) are only 79.3 percent of goals, which may indicate the start of a downward trend (Army Times, Sept 24 1984).

Error Analysis. The model has been developed to generate forecasts of enlistment contracts. Therefore the forecasting properties of the model are considered here. Since the model is estimated over 28 quarters, leaving only 21 degrees of freedom, relatively few back forecasts can be derived. We ran one quarter ahead forecasts for five quarters (1983 Q2–1984 Q2), calculating the mean squared error on the basis of percent changes over time. The error shares are then allocated between the regression, bias, and disturbance proportions (e.g. Theil, 1966). If the actual contract values (A_t) are regressed on predicted values (P_t), the regression can be expressed as:

20. $$A_t = \alpha + \beta P_t.$$

The bias proportion is zero if $\alpha = 0$. The regression proportion is zero if $\beta = 1$. The disturbance proportion remaining is the random error in the regression. Since the forecast error is expressed in terms of percent changes over time, the root mean squared error (RMSE) provides a measure of error in percent terms. The error allocation is provided in Table 6.

The RMSE is 2.8 percent, well within the range of respectable forecast error. The majority of the error is disturbance error, as expected. The bias proportion is quite reasonable, despite the fact that the number of contracts peaked in 1983 Q1 and began to fall in the following quarter. The bias proportion should fall even further given a longer forecasting horizon. However, the few degrees of freedom prevent using an extended forecast test. The disturbance proportion does account for over two-thirds of the error. This low bias and regression error indicates that the forecast model is performing well.

Table 7 presents actual ex-post quarterly forecasts and forecast errors for 1984 to date, in addition to forecasts for contracts through fiscal 1985. The downward trend in

TABLE 6

FORECAST ERROR ANALYSIS

Error Type	Error Proportion	Description
U^R	.123	regression proportion
U^M	.184	bias proportion
U^D	.693	disturbance proportion
RMSE	.028	Root Mean Squared Error

TABLE 7

QUARTERLY CONTRACT FORECASTS: GSM 1-3As

Fiscal Year	Predicted	Actual	Error	Error/Actual (Percent)
1983 Q4	16004	16502	-498	-3.0
1984 Q1	13952	14382	-430	-3.0
1984 Q2	15125	14818	307	2.1
1984 Q3	12454	12223	231	1.9
1984 Q4*	11654	—	—	—
1985 Q1*	10893	—	—	—
1985 Q2*	12777	—	—	—
1985 Q3*	10859	—	—	—
1985 Q4*	11292	—	—	—

*Does not reflect new increase in recruiting resources and higher missions.

GSM 1-3A contracts is clear, though the seasonality in the pattern of contracts creates small relative increases in the second and fourth quarters. The forecasts assume that unemployment continues to decline, although that scenario may be threatened towards the end of 1985 by interest rates rising in response to an increasing federal budget deficit.

These forecasts may perhaps be more accurately described as simulations. It is expected that the Army will in fact increase recruiting resources to meet the potential recruiting difficulty. Therefore the actual shortfall will most likely be much smaller than those given in Table 5. The latest data show that large increases in recruiting resources, in light of the projected shortfall for fiscal 1984, have indeed resulted in more enlistments, in which case the quarterly forecast for the last quarter of fiscal 1984 will substantially underpredict enlistment. The projections in this paper provide information on expected enlistment if everything else (including relative pay, recruiting resources), is held constant, and if the economy continues a smooth recovery to 1990. While the number of recruiters and national advertising are the only recruiting variables in the model, it is likely that other variables such as the level of resources available to the recruiters, or pressure on recruiters to produce, will influence the level of enlistment as well.

The aggregate time-series models are particularly useful for short-term projections. The model can be updated and estimated quickly and easily. In the long run, aggregation problems become important. Parameter estimates cannot be precise for this level of aggregations, and must be used with caution for policy analysis. Our model does not control for competition from the other services, nor for the fact that many recruiting districts met or exceeded recruiting goals during the early 1980's. These variables may be significant, although experimentation with limited information maximum likelihood (LIML) estimation utilizing the demand by other services in the time-series model did not yield satisfactory results. We emphaisze that the contract projections become very tenuous when predicting more than several quarters into the future.

VI. Conclusions

The U.S. Army could face serious recruiting problems throughout the remainder of the 1980's. The accession shortfall may reach at least 40 percent of target accessions if no policy changes are made. The two primary causes of this shortfall are the economic recovery and the continued decline in the population of eligible males. The model demonstrates that unemployment rates are an important determinant of enlistment, in sharp contrast with many previous studies. This shortfall will be reduced if appropriate manpower management policies are implemented.

The study demonstrates the effectiveness of several policy tools available to the Army. Military pay appears to have a large and significant impact on enlistment. This suggests that postponing or curtailing pay increases in 1985 will only exacerbate the recruiting difficulties caused by the drop in unemployment rates. The number of recruiters is also significant, as are national advertising expenditures.

Data suggest that the VEAP program is an important incentive for enlistment (e.g. Fernandez, 1982). However, since the program ceilings have remained constant over the entire period, there is no way to test the impact of the program in a time-series regression model. It appears that relatively few participants contribute the maximum amount in any case. Bonuses (including Army Kickers) are not significant in the model. Since one would expect increases in bonuses to be a response to enlistment shortages, this is not particularly surprising.

The model appears to fit the data well over the entire period, while the one period ahead forecasts for the last four quarters differ from actual contracts by 1.5 – 3.0

percent. The forecasts are expected to be less accurate as the projections approach 1990, and depend upon the state of the economy as well as military personnel policy. Analysis of the model suggests that the contract forecasts provide a reliable indication of future shortfalls which could be expected if the economy continues to recover, and if no effective manpower policies are implemented to reverse the trend. Recruiting initiatives have been planned beginning with the last quarter of FY 1984, which should reduce the shortfall projected by the model.

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